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TESTING THE VALIDITY OF VALIDITY OF CAPM WITH EMPIRICAL EVIDENCE FROM THE LONDON STOCK EXCHANGE IN THE PERIOD OF 2012-2020:
An examination of the validity of the Capital Asset Pricing Model in the UK financial market and the potential impact of size, value and momentum risk factors.

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International Business
Bachelor's Thesis
Supervisor: A. Can Inci
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ABSTRACT OF
BACHELOR'S THESIS

Author: Pham Hanh Trang **Tittle of thesis:** Testing the Validity of the Capital Asset Pricing Model with empirical evidence from the London Stock Exchange, in the period of 2012-2020: An examination of the validity of the Capital Asset Pricing Model in the UK financial market and the potential impact of size, value and momentum risk factors.
Date: 6 April 2021
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Objectives:
This paper aims at assessing the Capital Asset Pricing Model validity by attempting t answer the following research questions:

1. Does there exist a linear and positive relationship between systematic risk and the actual rate of return?
2. Is this relationship most significant on daily/weekly/monthly basis?
3. Is the UK stock market affected by other risk factors of the Fama & French three factors and Carhart four factors?

Summary:
Historical data of stocks listed on London Stock Exchanges (LSE) since 2012 is collected for the testing purpose, while the market benchmark index is the FTSE-100 Index. In testing for CAPM validity, this thesis adopts the simple linear regression method to examine the positive and linear relationship between Beta values and the average daily/weekly/monthly real return in the period of 2012-2020. To investigate the impact of other risk variables including risk, value and momentum on the UK financial market, two portfolios are formed for each factor, and the portfolio actual return are regressed against the UK market risk premium, respectively in the before and after BREXIT vote periods.

Conclusion:
Based on the statistical result, it can be concluded that the CAPM is not applicable for the UK stock market in the testing period on all three time-frequencies daily, weekly and monthly. Moreover, other risk factors namely size, value and momentum all have significant influence on the UK stock performance before the BREXIT vote; however, only value and momentum variable were still meaningful after the referendum's result was announced.

Key words: CAPM, CAPM Validity, UK financial market, regression analysis, market risk β.
Language: English

Grade:

Contents

1. Introduction

1.1 Background

As complicated as it is, the most basic, vital function of the capital market is to connect borrowers and lenders, either by direct channels such as loans or more indirect ones as equity, which guides investor's money into a lucrative investment, hence increasing their wealth and value. Despite the growing interconnection and free-flow of the international capital market, the old yet brilliant core mechanism behind the whole system remains the same: pricing. Pricing methods were developed from the assumption that each asset has its intrinsic value, being whether physical or financial.

In the finance field and stock specifically, the rational relationship between risk and rate of return has long served as the basis for pricing, and all asset pricing models were developed based on the rationale of this theoretical foundation. Unquestionably, the most popular, influential, yet causing much dispute of asset pricing models is the Capital Asset Pricing Model or CAPM (Fama & French, 1992). This model is heavily used in calculating the required rate of return for investors when owning financial securities. It is also applied in computing the cost of capital for companies as well as estimating instruments' prices (Lintner, 1965; Black and Scholes, 1972).

However, ever since its introduction, CAPM has been subjected to many controversies and criticism. Numerous researches has been conducted to test for the model's validity, which have produced a wealth of empirical results on the poor prediction ability of CAPM as well as the applicability in actual conditions of the stock markets. Nonetheless, the evidence that supports the application of CAPM is also as much as the evidence against it under almost six decades of investigation.

Recent times have observed the increase in the application of multi-factor asset pricing models, which proposed the idea that the security's actual return rate is not only influenced by the systematic risk but also other variables, namely the size and value variables (Fama & French, 1996), or momentum variables (Carhart,1997). While the Fama & French three factors model has shown to effectively explain 90% of the change in security's price (Fama & French,1996), the addition of Momentum factor introduced by

Carhart is demonstrated to boost the predictive power of the model up to 95% (Carhart, 1997).

Most of the discoveries were based on data retrieved from the US financial market; however, it is worthwhile to examine other markets as well. Within the scope of this thesis, the controversy of CAPM validity, the practicality of investment strategies built from its theory as well as how other risk factors may present themselves in the UK market will be discussed in detail.

1.2 Research Problem

Despite being a classic pricing model with prominent use by investors in portfolio investment, the CAPM's validity still is surrounded by fierce academic debate. As researchers are not yet to reach a universal common ground regarding the predictive ability of CAPM, numerous test methodologies are developed to test the model. Testing whether the CAPM applies to the London Stock Exchange through the unstable period resulting from the Brexit referendum in 2016 can assist investors in choosing the right method to value stock more reliably, thus avoiding losses in the long term.

Furthermore, even though CAPM is widely applied in portfolio management, multifactor pricing models such as Fama & French and Carhart are receiving more attention for offering better explanations for portfolio performance. This paper will employ samples from the United Kingdom financial market to carry out a statistical test to investigate the issues concerning the validity of CAPM in the UK and other risk factors, including size, P/E ratio, and Momentum that may influence the performance of stocks listed in the London Stock Exchange.

1.3 Research Question

In seeking the answer to the aforementioned problems, this thesis will attempt to address the below research questions:

4. Does there exist a linear and positive relationship between systematic risk and the actual rate of return?
5. Is this relationship most significant on daily/weekly/monthly basis?

6. Is the UK stock market affected by other risk factors of the Fama & French three factors and Carhart four factors?

The 1st research hypothesis examines whether there exists a positive linear association between market risk measured by Beta and the actual return of assets, as CAPM proposed. This is the most critical point in the testing of CAPM Validity, which will be elaborated on later in section 2. The next research question inquires about the consistency of different frequencies when testing the validity of CAPM. The final question considers other factors of Fama French and Carhart four factors that impact the UK market.

1.4 Research Objectives

Regard the research questions, this paper's objectives are as follow:

1. Collect and examine historical data in LSE to test for the strength of the linear relationship (if there is any) between systematic risk measured by Beta and the actual rate of return.
2. Run a regression test for the linear association on three-time intervals to decide to what extent that CAPM is applicable.
3. Discover how other factors, including size factor, P/E ratios factor, and momentum factor affect the performance of the stock in the London Stock Exchange.

1.5 Thesis structure

The order of this thesis starts with an extensive and comprehensive Literature Review that summarizes the origin, evolution, presumptions, principles, arguments as well as studies that have been conducted on CAPM, which will be followed by the main research hypotheses and conceptual framework. The next section is where the methodology for testing is presented which contains the overview of sampled data, investigated period, data testing process, the precise testing research questions, the statistical testing procedures, and the rule for rejecting hypotheses are presented. The results of all tests demonstrated in the Methodology section will then be shown in Findings, together with the result's interpretation, their indications for the research questions, as well as how they help to answer the hypotheses. Following this part is the Discussion that expands the finding's implications by comparing them with prior research. Finally, this thesis will end with the consolidation of main Findings, a critique of the study's limitations, and suggestions for further study.

2.Literature Review

2.1. Introduction

This literature review shall discuss the validity of three most ubiquitous asset pricing models, including CAPM, Fama French three factors, and Carhart through the re-examination of their explanatory power toward the relationship between securities' returns and market risks. Additionally, it will address the theoretical background behind the rationale of these three models and look through the past research regarding the validity and arguments surrounding these three models.

2.2. Efficient market hypothesis

A capital market is defined as efficient when it fully and correctly reflects all available information in deciding the share prices (Fama, 1970). Formally, as the market efficiency is evident, movement of expected price is supposed to be random with no distinctive patterns, as participants in the financial markets fail to forecast the prices implies information relevant to the stock was reflected in its price. Given the rationality of market, only behavior that is unanticipated or new information will have an effect on the security prices-and regardless of whether the information is good or bad. Indeed, competitive security markets are the root of market efficiency. According to Grossman and Sthglitz (1980), the efficiency level differs among numerous markets and that it is not always possible to achieve market equilibrium in competitive markets.

It has been customary since Roberts (1967) to distinguish three levels of market efficiency, depending on how the term "all available information" is defined. The first level is the weak form of the Efficient Market Hypothesis (EMH), which asserts that security prices reflect entirely all information extracted from past price patterns (i.e. prices, returns, trends) (ibid). Hence, it is impossible for investors to devise an investment strategy that gains abnormal returns based on analysis of historical price information. The next level is the semi-strong form of EMH. In a semi-strong efficient market, not only the historical data but also publicly available information related to a firm's stocks is reflected in the security prices. (Fama,1970). When a market achieves such efficiency, any fundamental analysis such as analysis of a company's balance sheet, public announcement of change in dividend payment will not be helpful in securing superior investment profits. The highest degree of market efficiency is strong-form that is notable to be extreme. For a market to be strong-form efficient, stock prices should entirely reveal all information that is acknowledged by all participants in the markets. It means that not even investors with privileged information can predict securities return or future price movement.

Numerous empirical researches have been conducted to test the Efficient Market Hypothesis (EMH), which demands an asset pricing model. The CAPM model is the most commonly used to test the EMH, along with other multi-factors models. As the investigation of EMH requires the asset pricing model, the result would involve two simultaneous tests: 1) efficient market hypothesis and 2) the asset pricing model. Despite the fact that efficient market seems to hold unrealistic assumptions, previous statistical researches have revealed diverse conclusions of EMH. In general, the technical analysis of EMH disagree with the hypothesis that it is capable of generating abnormal positive return.

Besides the diversion in the findings of efficient market hypothesis and different asset pricing model, conflict in price patterns is also disclosed by many researchers within their reports, most of which are unexplainable using CAPM.

2.3. CAPM

CAPM was formerly introduced by Sharpe (1964) and Linter (1965), and has since served as the core of modern finance as well as pioneered late asset pricing theory, as indicated by Fama & French (1992). Due to the cardinal importance of determining the "fair value" of an asset to the financial market, CAPM, being a powerful and intuitively pleasing tool for such purpose, has witnessed virtually sixty years of wide application by financial researchers and investors. CAPM is not only useful in estimating the cost of capital for firms and thus the rate of return, both of which are essential for pricing asset and planning corporate finance, but it also provides the frame to evaluate the performance of managed portfolios (Fama & French, 2004). Even though there existed previous idea and application of linking risk with required rate of return, CAPM is known to be first framework that “describe the manner in which the price of risk results from the basic influences of investor preferences and the physical attributes of capital assets" (Sharpe, 1964), hence equipping financial investors with a logical and systematic pricing model.

Ever since CAPM started exerting its effect on the theoretical development of modern finance, the debate surrounding its validity remains heated among financial researchers, the critics of the models are based on both theoretical claims and empirical evidence. The findings of CAPM empirical testing were diverse since it was first introduced. There are three main controversies concerning the application of CAPM, namely its simple assumptions of the stock market, its presumption that all investors have homogeneous views concerning risk, and its estimation of linear Beta (Black, Jensen, & Scholes, 1972). There are some studies’ findings that do suggest a positive linear association between risk level and required rate of return, hence validating the presumptions of CAPM (Black et al., 1972; Lau, Quay, & Ramsey, 1974). In contrast, other academics have reported empirical evidence that challenge the validity of CAPM by emphasizing on its flawed assumptions.

Theoretical Foundation of CAPM

CAPM is an attractive asset pricing model thanks to its characteristics of being simple as well as its ability to offer compelling and intuitively pleasing predictions of ways to estimate investment risk as well as the correlation between required rate of return and risk (Fama & French, 2004).

The idea of tying required return to risk was first proposed by Markowitz, who asserted that as the future is unpredictable, risk is required when calculating the rate of return on portfolios, (Markowitz, 1952). This idea suggests that investors always have to make a compromise between risk and return, if they invest in a riskier stock, they can expect a higher return and vice versa. From this argument, together with the presumption that investors are purely risk-averse, Markowitz had developed the Modern Portfolio Theory (MPT), also called Mean-Variance model. This model presents the “mean-variance-efficient" portfolios that investors would always theoretically choose. Such portfolios are supposed to maximize the discounted value of future return, given variance while minimizing the risk level at a given required rate of return (Markowitz, 1952).

The theories and model developed by Markowitz was important to modern finance as it serves as a foundational for later asset pricing models, with the most notable being CAPM.

The rationale underlying CAPM

CAPM was constructed from the groundwork of the aforementioned Modern Portfolio Theory model by Harry Markowitz (1959). One major assumption of the theoretical foundation for this model is that all participants in the stock market are homogeneously risk-averse, whose main consideration is the mean and variance of their one-period investment return (Fama&French,2004). Therefore, participants in the financial market would naturally request a higher expected rate of return from a higher risk portfolio, which can adequately compensate them for the extra risk they bear. The Markowitz's MPT model also depicts how investors are supposedly pursuing the "mean-variance efficient" portfolio that maximize return, given risk measured by variance or minimize the risk level at a certain required rate of return (Fama & French, 2004).

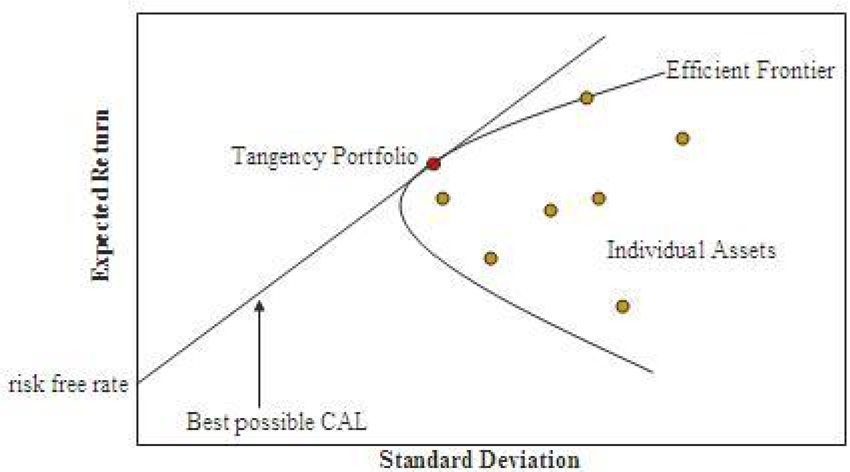
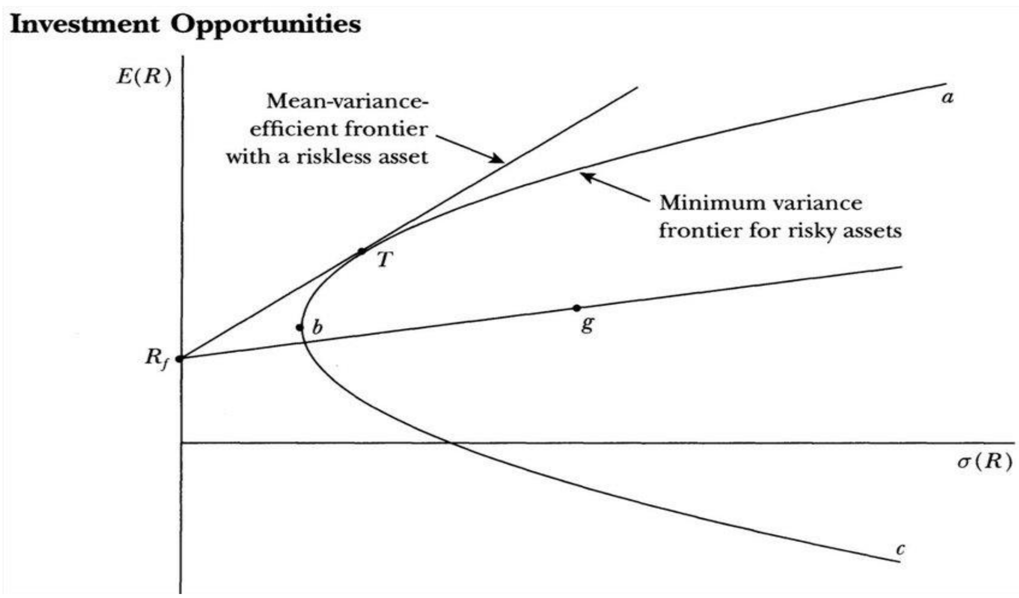


Figure 1: Efficient Frontier in Markowitz 1952 MPT

The model above illustrates the "risk-expected return space" consisting of every available sets of risky assets that make up a portfolio, with the y-axis representing the expected return on the portfolio, while the standard deviation of the portfolio, which measure its risk level is on the x-axis. Given that there is no opportunity to incorporate risk-free assets, the “efficient frontier” is the portion of the hyperbola that lies in the upward-sloped top boundary of this region. This efficient frontier contains exclusively efficient portfolios which offer the highest rate of return at a given variance or risk level. If a risk-free asset is allowed, the set of opportunity is enlarged, the efficient frontier becomes the straight-line segment starting from the vertical axis at the risk-free rate value and tangent to the risk-assets-only opportunity set. From the MPT’s theories, Fama and French (2004) developed the CAPM’s logic to a greater depth.



The model proposed by Fama and French (2004) was based on the model Markowitz (1952) developed, where the return’s variance, indicating the portfolio’s risk is on the horizontal axis and the vertical axis represent the anticipated return on asset. If risk-free assets are not allowed, the region in the upper half, meaning the curve above point b, is the graphics depiction of “mean-variance efficient” portfolios. Otherwise, with the allowance for risk-free assets through either long or short positions, the “mean-variance efficient” portfolios turns into the straight line that tangent the hyperbola at T.

CAPM Equation

The fundamental foundation underlying CAPM is that there should be a compensation for investors when bearing any risk that exceeds risk-free rate (Fama & French, 2014; Hanif, 2010). Total risk of an asset consists of two elements, the first one is the firm-specific risk, which can be got rid of by portfolio diversification, the other is market risk and cannot be diversified away. Investors do not gain any excess return for bearing the unsystematic, for example, a firm's unexpected news, since this risk can be eliminated through diversification (Lau, Quay & Ramsey, 1974). Nevertheless, investors receive excess return as compensation for bearing systematic risk as this risk naturally exists in the stock market and cannot be eliminated. CAPM is developed specifically to address this market risk, the risk inherent in the whole market and is illustrated by Beta, which measures the change in an asset's return, corresponding with the fluctuation in the financial market (Fama&French, 2014). Based on these aforementioned principles, the CAPM equation is as follows:

$E(R_i) = R_f + \beta (E(R_m) – R_f)$

Where:

E(Ri) is the required rate of return on asset i

Rf is the risk-free rate

E(Rm) is the expected market return.

β is the Beta of asset i

(E(Rm) – Rf) is the market risk premium.

β (E(Rm) – Rf) is the asset risk premium.

As it can be seen in the equation, there exists a positive linear relationship between risk and return, which is graphically demonstrated by the security market line (SML) as below.

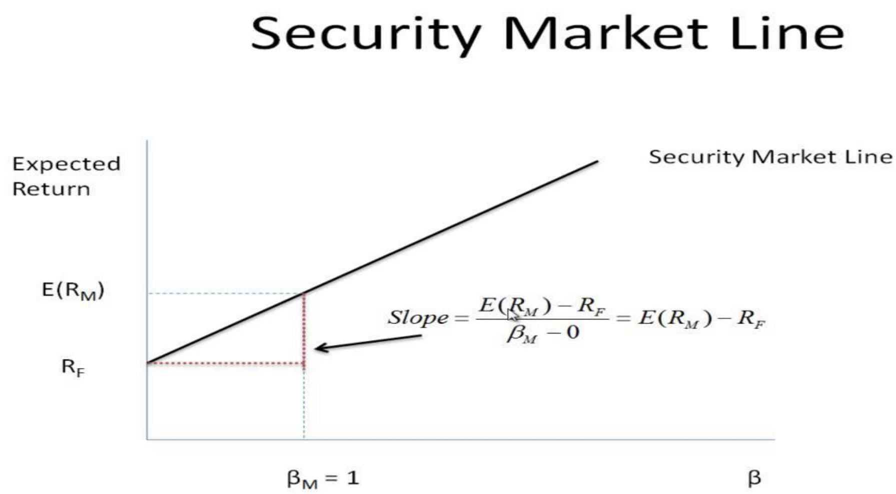


Figure 3: The Security Market Line by Fama and French (2004)

In the above figure, Beta is illustrated by the x-axis, while the expected return on asset i is depicted by the y-axis. The slope of the security market line is the market risk premium, calculated as E(Rm) - Rf. Stocks on the higher part of the SML are those with higher risk, hence offer investors higher return. The total required rate of return is equal to the sum of risk-free rate and asset risk premium. Beta represents the correlation between market performance and asset's, hence the market Beta is always equal to 1. Assets that have a higher Beta means that they are riskier, and anyone investing in those should expect compensation for the extra risk they bear and vice versa. The equation for computing individual asset Beta is below:

$$\beta i = cov(R\text{i}, R\text{m}) / var(R\text{m}) = [\rho(R\text{i}, R\text{m})\ \sigma\text{i}\ \sigma\text{m}] / var(R\text{m}) = (\rho(R\text{i}, R\text{m})\ \sigma\text{i}) / \sigma\text{m}$$

Where:

Ri is the return of the asset i

Rm is the market return

Portfolio Beta can be calculated by simply taking the weighted average of all assets constructing it.

Discussion of past studying about CAPM

Despite the extensive adaptation of CAPM in the finance field, the model is still subject to fierce contention. The most controversial issue concerning the applicability of CAPM lies in its fundamental assumption, which is regarded as oversimplified and impractical.

The previous tests of CAPM usually concentrate on examining the three implications inferred from the β-expected return relationship. The first implication is about the role of β as the only measurement of market risk and the linear relationship between β and the required rate of return. Secondly, the SML's intercept (Security Market Line) that graphically represents the CAPM formula, should be risk-free return. Lastly, the slope of the SML must be positive, meaning the market risk premium is always larger than zero.

Studies that validate the application of CAPM

For as long as CAPM centered the financial market, various studies were conducted to test, many of which, especially the research in earlier years, have reinforced its validity. A study by Jensen, et al. was undertaken in 1972, which involved the construction of a portfolio of publicly listed stocks in the NYSE from 1931 up to 1965 with the market return was computed by taking the monthly return data of an equally weighted portfolio of all NYSE stocks. The findings of this study indicated a linear association between β and the excess portfolio return. In 1973, Fama and Macbeth reaffirmed this evidence with their study that adopted a two-pass regression approach and revealed an increasingly obvious existence of the linear relationship over a longer time period. Some more recent researchers also confirmed the applicability of CAPM. Lau et al. (2013) came to a conclusion that CAPM was valid in the Japanese securities market after running a test with stocks in Tokyo Stock Exchange (TSE) in the period 1964-1969. Moreover, Jagannathan, et al. (2012) concluded that the Capital Asset Pricing Model presents a fair estimation for firm's cost of capital, as long as any embedded related real options are assessed separately for capital budgeting goals. Another research by Dowen (1988) declared that Beta and portfolio's expected return are strongly, linearly related, and even went far to present the argument that solely β is adequate for effective asset pricing, assuming that the firm-specific risk is all diversified away; nevertheless, he also highlighted that practically, no portfolio would be large enough to achieve such diversification. (another tests support CAPM)

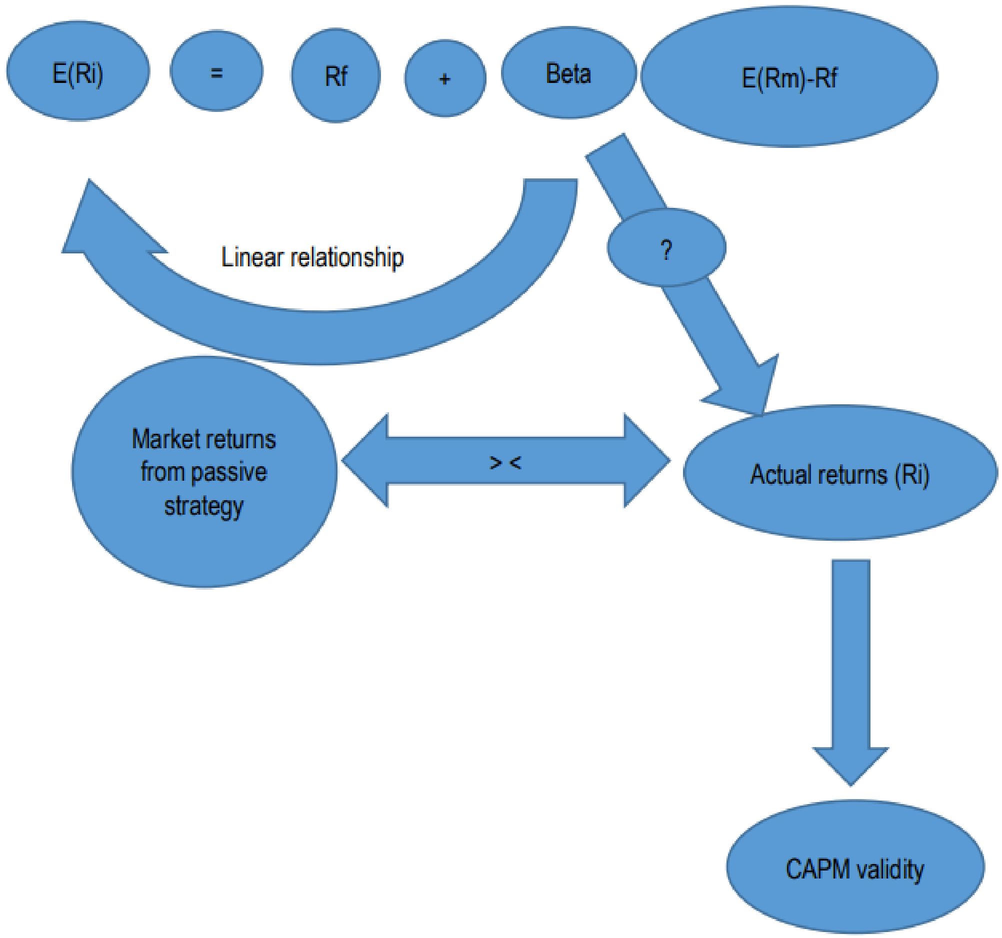
Studies that invalidate the application of CAPM

On the other hand, empirical evidence that challenge the validity of CAPM abounds to the degree of seemingly overwhelming those to the contrary (Nyangara et al., 2016). CAPM is commonly attacked for assuming that β is the sole measurement of risk. Not long after CAPM was introduced, Basu (1977) and Banz (1981) have already criticized the validity of the model with empirical evidence showing that that CAPM fails to explain the size effect as an anomaly, as the sole usage of β to estimate asset return would lead to biased results. This conclusion was later approved by Fama & French (1992) after conducting their own empirical test with the NYSE-listed stocks. Another factor other than β that is revealed to have an impact on the portfolio's return is Price-to-Earning (P/E) ratio. According to Fama & French (1996), firms with low P/E ratio yield higher return than the ones with high P/E ratio. Moreover, the P/E ratio is revealed to have a positive relationship with return (Fama & French, 1996).

Entering the 21st century, there is an increasing number of researches that put the validity of CAPM into question, stating that assets ' actual return cannot be explained entirely by market beta. The lack of CAPM's empirical record invalidates the way it is used in application (Fama &French, 2004). It is indicated that numerous other factors such as firm's size, P/E ratios, debt-equity ratios have significant impact on the performance of the portfolio, which is previously only explained by the market beta and the relation between β and the actual asset return, although positive, is indeed too flat. Mateev has accepted the Fama and MacBeth cross-sectional method in testing CAPM on the Istanbul Stock Exchange and came to the conclusion that other than Beta, size and B/M also occupies a crucial role in deciding the stock price. Another study by Džaja and Aljinović (2013) examined the validity of CAPM on the emerging financial markets in Central and Southeast Europe using monthly stock returns for nine countries for the time frame of January 2006 to December 2010. Utilizing the cross-sectional regression analysis, the study tested if Beta, being the single risk measure, is valid and concluded that return and Beta did not positively and linearly correlate with each other, hence CAPM did not suffice in assessing the capital assets in the observed stock markets. In Malaysia, Rui et al (2014) conducted a CAPM test with stocks publicly listed on Malaysian Stock Exchange and discovered that CAPM is far from effective for the Malaysian securities market during the sample period. Furthermore, in the US financial market, the Securities Market Line (SML) was much flatter than that estimated by CAPM as reported by Frazzini and Pederson, which provide more evidence for the findings by Fama and French (2004). The more CAPM tests were undertaken, the more problems with the model were (discovered) by researchers. For instance, Conrad, Dittmar, & Ghyseis (2003) showed the significance of skewness and kurtosis in explaining stock expected return, or Nyangara et al. revealed the effect of liquidity in their study in 2016.

Conceptual Framework

The conceptual framework here aim at depicting CAPM and how it is relevant to the research problems presented above, The below figure represents the CAPM formula and the linear relationship between expected return and systematic risk. Whether the actual rate of return will support such relationship is one focus of this paper's empirical test.



Conceptual Framework

2.4. Fama French three factors

In one of their study in 1996, Fama and French revealed that size and book-to-value equity (BE/ME) are significant in explaining the securities return. ME variable is computed by multiplying stock's price with the amount of outstanding shares at the end of June in year t. BE/ME is defined as equity's book value (BE), at the end of December of year t-1, divided for the equity's market value (ME), at the end of December of the same year. These two variables are important to the calculator of asset actual return's Variance since they account for the underlying risk of stocks.

As stated by Fama and French (1992), value firms, meaning firms with high book-to-market ratio are consistently performing strongly; in contrast, growth firms, meaning firms with low book-to-value ratio, tend to display poorer performance. Concerning the size variable, the researchers concluded that the stock returns of larger firms tend to outperform that of smaller ones. Thus, the Fama &French three factors model added two other factors to the original CAPM, which are illustrated by small minus big (SMB) and high minus low (HML).

According to Chan et al. (1985), the size effect is normally more related to default risk that is priced as a premium in return. They further discovered that distressed firms are more subjective to external economic turmoil that have negative impact on the income prospects of the company, hence, there should be a premium for holding these companies.

There exist studies that question the model proposed by Fama and French, claiming that it cannot explain the BE/ME and size effect, and the risk premia are economically immaterial. Instead, the risk premium for firms with high BE/ME ratios and small firms are merely results of chance, despite the existence of these two risk premia in various regional markets for a long period (Black, 1993 , MacKinlay (1995)).

Also after conducting their test in the Pakistani stock market, Javid and Ahmad (2011) disclosed that Fama &French three-factor model show a more superior performance compared to CAPM with the presence of news asymmetry. Also, in the Pakistani securities market, Hasan and Javed (2011) have attempted to investigate the association between value premium, size and stock returns by adopting the 3FM model to test for 250 stocks on Karachi stock exchange (KSE). The result revealed that the portfolio's actual returns are strongly positively relevant to the size variable.

According to Fama &French (1996), the CAPM is not appropriate in explaining the abnormal patterns of securities returns owing to its specification. Furthermore, in their later research in 1998, they observed that in twelve out of thirteen major subject international markets, value stocks displayed an apparently better performance than growth stocks. They also reported the effect of firms' size on the stock return as equities of smaller companies outperform equities of larger one in eleven of sixteen examined markets. This result was examined by Kothari et al. (1995) whose objective is to decide if value factor can capture the cross-sectional variance in the average return and if Beta is sufficient in explaining the cross-section return's variation. They utilized the S&P

industry level data for examination and later reached the conclusion that book-to-market ratio has a loose relationship with the average stock return. They also identified a considerable survivorship bias in selection of both firm price-to-earning ratio and value sorted portfolios because, as they pointed out, the primary databases entail exclusion of information relating to various stocks with high book-to-market ratios and stocks from small firms that no longer exist.

On the contrary, there are many studies' findings empirically support the conclusion of Fama & French (1993, 1996). A study by Barber and Lyon (1997) depicted how the data snooping assertion can be eliminated by utilizing different time spans of samples in different nations. Lakonishok et al.(1994) provided another economic evidence for high premium between high and low B/E stocks, they used monthly returns of 10 size sorted portfolios to compute the average annual premium to be 10.5%. This premium can be attributed to investors' false preference, who normally hesitate to invest in high B/E owing to their poor past performance and inferred to under performance in the future also.

Another investigation by Daniel and Titman (1997) examines the consistency of the return patterns of characteristics sorted on portfolios with the factor model. They then concluded that no apparent separate risk variables that relate to high or low BE/ME characteristic companies exist, and also no excess return relevant to any of the three factors that Fama & French suggested can be found. This indicates that the high return of these portfolios can not be perceived as the compensation of factor risk that investors bear; instead, they revealed in their later study that BE/ME and size premia results from the common characteristics of companies. The identical behavior of stocks with the same ME or BE/ME ratios can be economically explained by the existence of contemporaneous movement, hence they are under the impact of the same factors. Market inefficiency and mis-assessment are two other likely reasons which explain the premium between equities from different classes.

In proving the risk compensation claims against Daniel and Titman's behavioral explanation, Fama & French (1998), Davis (2006) adopted the same method of sorting stocks based on their ME and book-to-market ratios and risk loading, who then claimed that the relationship between return and firm characteristics are explain better by 3Fm than the behavioral rationale. Furthermore, after inspecting the securities return and companies' characteristics they discovered that the conclusion by Daniel and Titman (1997) is the result of data bias as it is specific to only their observation time frame of 20 years.

Other academics have also adhered to different underlying economic rationales in an attempt to explain the observed risk premia by the associated risk.

One such study was conducted by Agarwal and Poshakwale (2006), which use the stock publicly listed in London Stock Exchange in the period of 1979-2002 to appraise the correlation between size and high book-to-market and distress risk effect. The study's result substantiated 3FM's assumption that there exists a relationship between distress risk and firm's size, however, it also disclosed no monotonic association of distress risk and book-to-market ratio. More specifically, even though stocks in the book-to-market ratio quintile portfolios displayed the highest failure rates, it does not decline when moving to lower book-to-market quintiles. Hence, they established that although the explanatory power of FF3 is better than that of CAPM in the UK market, the model is more applicable to the US financial environment.

The model for computing expected return as proposed by Fama and French:

$$\boldsymbol{Rit - Rft = \alpha it + \beta 1(RMt - Rft) + \beta 2SMBt + \beta 3HMLt + \epsilon it}$$

Where:

Rit=total return of a stock or portfolio i at time t

Rft=risk free rate of return at time t

RMt=total market portfolio return at time t

$Rit-Rft$=expected excess return

$RMt-Rft$=excess return on the market portfolio (index)

$SMBt$=size premium (small minus big)

$HMLt$=value premium (high minus low)

$\beta 1,2,3$ = factor coefficients

2.5. The Carhart's Four Factor Model (4FM)

Even though FF3 is widely accepted as a more valid asset pricing model that offers a better explanation for stock return compared to CAPM, researchers still put a lot of effort into enhancing its prediction ability. The most well-known improvement belongs to Carhart (1997), who proposed including a momentum anomaly variable as he discovered that 4FM works better with time series variation. In his study, Carhart (1997) has investigated the returns persistence of mutual funds to identify that most of stock's abnormal returns are explainable by adopting the one-year momentum. Specifically, it is stated that assets which demonstrated a relatively strong price movement in history tend to award investors with more chance of superior earnings (Levy,1967). In a later study by Davidson and Dutia (1989), they also established an existence of a positively statistically significant correlation between assets' abnormal return in one year and the next year. The tendency that poor performers continue to perform poorly and strong performers continue to perform strongly (momentum) establish the ground of the rule and poses a considerable challenge to the efficient market hypothesis (EMH) because all relevant information about the stocks is not instantaneously reflected in its price before the next period.

Another research by Grundy and Martin (2001), which applied the Carhart four factors model to test for stock in the US market, has disclosed important findings. Firstly, they discovered that investors can achieve an average of 1.34 percent return every month if they arranged a two-factor and three-factor. Secondly, they revealed that neither industry impacts nor cross-sectional variation in the predicted return contribute to the profit when employing the momentum strategy, contrary to the findings of preceding studies (Grinblatt and Moskowits, 1999).

Rouwenhorst (1998) provided empirical evidence that justified discoveries by previous studies on strong small cap momentum, revealing that the continuation of momentum normally persisted for roughly a year. Additionally, a statistically significant association between the US stock markets momentum and the European stock markets momentum is identified, suggesting the existence of a mutual international momentum factor.

According to Nijman et al. (2004), neither differences of industries nor countries can provide an adequate explanation for momentum strategy, which contradicted earlier research. Instead, when examining the style and market capitalization, they announced that small cap growth stocks tend to profit more from momentum than large cap value stock.

Concerning the effect of momentum in developing markets like Asian, Hameed and Kusnadi (2002), Ryan and Curtin (2006) concluded little evidence of momentum can be found in such markets, while other researchers including Ramiah et al. (2011), and Brown et al. (2008) found that momentum proved to be profitable in numerous of Asian financial markets. Specifically, Cheng Wu (2010) revealed an insignificance of momentum profits in Hong Kong stock, and the momentum variable showed a fairly weak impact on the East Asian markets. In Thailand and Taiwan, the momentum factor's evidence is relatively weak and negative, according to Du et al. (2009) and Fu & Wood (2010).

As it is mentioned above, researchers generally agree on the significance of momentum factor, however, the cause of such positive relationship in return are still subjected to fierce contention. There exist two major types of arguments, these first one related to the claim that model is mis-specified (Wu and Wang, 2005), cost of transaction (Lesmong, 2004), supporters of these arguments asserted that the effect is more obvious than real that can be explained by rational reasons. On the contrary, some other researchers disagree and claim that the irrational act of investors is the reason behind such impact, including underreaction (Jegadeesh & Titman, 1993), presumption (Daniel et al.,1998). All in all, the joint-hypothesis is highlighted that the inefficiency in the market or investors' irrational act might not cause the abnormal return but rather merely the sign of model inefficiencies adopted to compute abnormality in assets' return.

Researchers who promote standard finance theory declare that flaws in designing methodology can contribute to the evidence of momentum. One instance is Conrad and Kaul (1998), who claimed that momentum effects are caused by cross-sectional variation instead of (predictability) in time-series variation as stated by some previous studies.

On the other hand, Chordia and Shivakumar lagged macroeconomic factors, including inflation rate, GDP growth etc. are the reasons behind abnormal momentum profits. According to them, time-varying anticipated return, instead of investors' behaviors, is the cause of momentum profits. This conclusion is supported by O'Sullivan (2010) & O'Donnel and Baur (2009), who discovered that momentum strategies yield considerable returns during market growth. There are also other researchers who have attempted to explain the momentum effects by the breakdown of returns. They investigate the likelihood that the momentum effect presents at the company specific level or national level to explore the generator of return continuation. The company-level factors of momentum stocks include size and book-to-value ratios. Also, according to Jegadeesh and Titman (1993), investors are most likely to generate highest profits in December,

Carhart 4 Factors equation

E(Ri) -Rf= α + Bi[E(Rm)-Rf]+Bs E(SMB) + Bv E(HML)+ Bm E(MOM)+

Where:

E(Ri)= The expected return on asset i

Rf= The risk-free interest rate

E(Rm)=The expected return of the market

E(SMB)The expected return of the size variable

E(HML)=The expected return on the BE/ME variable

E(MOM)= The expected return on the momentum variable

Bi, Bs,Bv,Bm= The coefficients or the betas of the three independent variables SMB, HML,MOM

3. Methodology

This methodology focuses on describing and explaining the methodology by which this research examines the aforementioned hypotheses. The chapter shall begin with the description of the data collection method and process that encompasses the investing period, the data sources, and the benchmark index that served as the representative of stock's performance in the UK financial market. Additionally, the steps by which simple linear regression is adopted for investigating the stated research hypotheses are also examined and elaborated.

3.1. The Benchmark Market Index

As priorly discussed, one of the main problems plaguing the empirical testing of CAPM is the researchers' inability to reach an agreement on the construction of an index representative of the stock market. This "market index" is a lynchpin in statistical testing because its return impacts the computation of Beta itself, hence the required rate of return computed from CAPM. Within the scope of this thesis, which centers on the UK stock market, the selected benchmark index is the FTSE-100. The FTSE-100 is the share index of the top 100 firms publicly listed on the London Stock Exchange, the main stock exchange in the UK. The FTSE Group computes the FTSE-100 in accordance with their mandated Paasche Price Index Formula as shown below:

$$I_t^{Paas} = \frac{\sum_{i=1}^{n} P_{i,t}\, Q_{i,t}}{\sum_{i=1}^{n} P_{i,0} Q_{i,t}}$$

It^{Paas} = Paasche Index

$P_{i,t}$ = price at the start of day t for constituent i after adjustments for corporate action or event

$P_{i,0}$ = price of constituent i on the starting day of calculating the index

$Q_{i,t}$ = number of shares included in the index for constituent i at the start of day t.

FTSE 100-Index is quoted on streaming platforms with a minimum of a 15-minute delay. All data and information relevant to the FTSE-100 Index can be retrieved from finance.yahoo.com.

3.2. The Studied Period and Investigation Frequencies

This paper examines an 8-year period from 2012-2020, which would be applied in two approaches in answering the two first hypotheses under analysis.

To test the first hypothesis in the CAPM theories, which is the existence of a positive and linear relationship between systematic risk measured by Beta and the actual assets' return, the Beta and rate of return of 30 randomly publicly listed stocks on LSE are computed for the sampled period of 8 years from 2012-2020 (precisely from January 1, 2012, to December 31, 2020). Three time frequencies - daily, weekly, and monthly are employed to test for the above characteristics of each stock. The purpose of sorting and testing based on daily, weekly, and monthly basis is to decide the likelihood of time interval impact on the testing results and to examine whether CAPM application has a "preferred time-frequency".

Moreover, this paper applies CAPM in investigating the other risk factors, namely the size, value, and momentum factor as well as the influence of the BREXIT referendum on the performance of stock publicly listed on the London Stock Exchange. For examining the size and value variable's impact, the investigation of the selected stock would be divided into 3 and a half year periods, from 2012-2016 (specifically from 01/01/2012 to 24/06/2016), the period before BREXIT, and after the British decision to leave the European Union (from 25/06/20 to 31/12/2020). As for the momentum factor, the chosen stock is examined in two time spans, the first one is one year before the referendum (from 24/06/2015 to 24/06/2016) and the second one is one year after the BREXIT announcement (from 25/06/2016 to 25/06/2017). The regression tests are conducted for all periods mentioned above, whose results will then be compared to identify the influence of different risk factors on the UK stock market.

3.3. The Sampled Stocks

The sampled data included in this paper are the daily, weekly, and monthly adjusted close price of stocks that construct the FTSE100 Index, and FTSE100 Price Index retrieved from the Thomson Datastream database. 8 firms that contained some NA variables have been eliminated. The risk-free rate employed here is the daily yield of 10-year UK government bonds collected from Thomson Datastream. To construct an unbiased sample for an eight-year testing period, the simple random sampling method is adopted for the purpose of choosing randomly 30 stocks out of 101. Data of these 30 stocks will be utilized for answering the first and second hypotheses.

For the last hypothesis, this paper will select stocks of the three biggest and smallest companies in terms of market capitalization for examining the size variable. Regarding the value variable, three stocks from companies with highest average P/E ratios and three stocks from companies with lowest P/E ratios are being chosen for testing. Lastly, three up-moving stocks and three down-moving stocks will be used for the momentum variable.

3.4. The Research Method: Simple Linear Regression

The three major research questions this paper seeks to answer are:

1. Does there exist a linear and positive relationship between systematic risk and the actual rate of return?
2. Is this relationship most significant on daily/weekly/monthly basis?
3. Can the factors in Fama-French three factors and Carhart four factors better explain the UK stock market?

This paper employs the simple linear regression method, specifically the Ordinary Least Square (OLS) to seek answers to the aforementioned questions through empirical testing. This method is utilized for determining the slope as well as intercepts of the related regression equations. OLS is recognized as appropriate for this thesis's objectives as OLS estimation is the fundamental testing tool for most asset pricing model validity researches. Numerous previous researchers have adopted this approach in their studies, including Fama and Macbeth (1973) and Kurach (2012) who applied OLS estimation in calculating Beta

3.4.1 Computing the actual rate of return and Betas

In answering the first and second research hypotheses, there is a need for the calculation of the Beta value and asset's rate of return on all three time intervals. The following equation demonstrates how the simple return method can be used to generate the required rate of return of the examined stocks.

$R_{i,t} = (P_{i,t} – P_{i,t-1}) / P_{i,t-1}$

Where:

$R_{i,t}$: The actual return rate of stock i at time t.

$P_{i,t}$: Price of stock i at time t.

$P_{i,t-1}$: Price of stock at time t-1.

The simple method is more suitable for this thesis than the log-return due to some following study-specific purposes. It is true that the log return method is normally preferable among researchers as it offers some advantageous properties including the log-normality and time-additivity and it sums up across time, not assets. In contrast, simple returns do sum up across assets, also the return of portfolios is the weighted value of its constituents' simple return. Due to these reasons, researchers that conduct portfolio data analysis, such as Hanif (2010), Khan et al. (2012) have adopted this method in their studies. Since this research's purpose is to examine a constructed portfolio return for the 3rd research question, the simple return is a preferable choice. Furthermore, simple returns is also selected as a method for computing its FTSE Index return, the index that acts as the rate of market return for this research. Altogether, the sample period, which is divided into two shorter periods (2012-2016 and 2016-2020) generated 2350 daily, 470 weekly, and 108 monthly observations of return rate for each examined stock.

After completing the computation of the examined stock's rate of return and the benchmark FTSE-100, the computation of that stock's Beta can proceed. The formula for calculating Beta values is shown below:

$\beta i = cov(Ri, Rm) / var(Rm)$

or $\beta i = [cor(Ri, Rm)\ \sigma i\ \sigma m] / var(Rm)$

Where:

Ri is the real rate of return on stock i

Rm is the rate of return on the FTSE-100 Index

σi is the variance of the return on stock i

σm is the variance of return on the FTSE-100 Index.

3.4.2 Deconstruction and examination of the regression analysis, its hypotheses, and its components.

In addressing the first research hypothesis, which considers the positive and linear relationship between market risk measured by Beta and the assets' rate of return, as proposed by CAPM, the following regression analysis will be conducted, in which the Beta values of the examined stocks are the independent variables and the expected return are the dependent variables. A linear equation that predicts the rate of return value, the dependent variable, with a given Beta can then be estimated using regression analysis. In answering the second hypothesis of on which time-frequency this association is meaningful, the above regression analysis is repeated for daily, weekly, and monthly observations in the investigated period from 2012-2020.

The equation below denotes the association between beta and rate of return:

$$R_{i,t} = \alpha 1 + \beta i.\ \beta 1 \quad (1)$$

Where:

$R_{i,t}$ is the average rate of return on stock i in the examined time interval for the sampled period.

$\alpha 1$ is the predicted equation's intercept.

$\beta 1$ is the predicted equation's slope.

βi is the Beta value of stock i in the examined time interval for the sampled period.

In the above formula, slope $\beta 1$ determined the nature behind the relationship between the Beta of stock i and its rate of return. When and only when $\beta 1$ is significantly different from 0, which can be decided from investigating the p-value of the t-test for $\beta 1$ and its confidence interval that a conclusion of such positive and linear relationship can be drawn. Hence, the following hypotheses:

- H0: $\beta 1 \leq 0$ (the relationship is significantly positive and linear)
- H1: $\beta 1 > 0$ (the relationship is not significantly positive and linear)

Particularly, the research hypotheses for each time-frequency are as follow:

- H0a: β1a ≤ 0 (there is no significant positive and linear relationship)
- H1a: β1a > 0 (there is a significant positive and linear relationship on the daily frequency)
- H0b: β1b ≤ 0 (there is no significant positive and linear relationship)
- H1b: β1b > 0 (there is a significant positive and linear relationship on the weekly frequency)
- H0c: β1c ≤ 0 (there is no significant positive and linear relationship)
- H1c: β1c > 0 (there is a significant positive and linear relationship on the monthly frequency)

As practically applied in finance**,** the selected level of significance here is a standard α=0.05, meaning that the null hypotheses would be rejected at this threshold. The t-test's p-value of the matching slope for each pair of these above hypotheses needs to go below this significance level, meaning that p-value < 0.05, whereas the confidence level should not contain any negative or 0 value.

3.5. Constructing portfolio to answer the third research hypothesis:

As previously discussed, this paper will also consider other factors of Fama French three factors and Carhart four factors that may impact the performance of stock listed in the London Stock Exchange. Most selected samples are examined in two different periods, the first period is before the BREXIT vote, from 01/01/2012 to June 2016,(24/06/2016 specifically), the second one is after the referendum until the end of 2020. Only the samples selected for the momentum factor are examined in a two-year period (from 24/06/2015 to 25/06/2017)

To start with, in determining whether a company's size has a significant effect on how stocks in the UK financial market perform, three small UK companies and three large UK companies, ratios are selected for the testing purpose. For three small-size companies, the CAPM model will be utilized for estimating the average Alpha and Average Beta, using before the referendum data and after the referendum respectively. The same analysis is also repeated for the three large UK firms. After the computation of all average values, those averages will be compared with each other to investigate the influence of the size factor on the UK stock exchange. A statistically significant difference in the above comparisons will imply that size variable is meaningful in the UK stock exchange, hence, should not be ignored.

Similarly, to explore the significance of P/E ratio factor on the performance of stocks on the London Stock Exchange, this study will select three growth companies with high price-to-earnings (PE) ratios and three value companies with low PE ratios then repeat the same steps as with the size variable.

For the momentum factor, the investigating period is the two years surrounding the Brexit vote, specifically from 24/06/2015-24/06/2016 and from 25//06/2016 to 25/06/2017. During the first period, based on the average daily return computation, three stocks that displayed the best and worst performance would be chosen to form two different portfolios, namely the up-moving portfolio and the down-moving portfolio. The regression test will then be conducted for both portfolios on both periods to identify the average Beta and average Alpha. The final step is to compare these averages with each other to examine the momentum impact on the UK stock market.

The regression equation is as follows:

$$\mathbf{R_{e,t} = \alpha + \beta .\ R_{m,t}}$$

Where:

$R_{e,t}$ is the excess return on the constructed portfolio at time t, calculated as Return on asset - Rf (risk-free rate) at time t.

α is the predicted equation's intercept.

β is the predicted equation's slope.

$R_{m,t}$ is the market excess return, calculated as Rm (return on FTSE100 Index) - Rf (risk-free rate) at time t

Based on the above formula, the average α and β resulting from the test of each risk factor will be compared to examine whether there is a statistically significant difference of stock with certain characteristics before and after the BREXIT referendum, the process in which a t-test with its resulting p-value is required. If the α and β of two portfolios in each risk factor before and after Brexit are statistically significantly different from each other then conclusions about the powerful impact of that variable can be drawn. On the contrary, if there is no significant difference identified, it can be concluded that factor does not have much influence on the performance of the UK security market.

The hypothesis for the regression can be presented as below:

- H0a: $\alpha1 = \alpha2$, $\beta1 = \beta2$ (There exists no significant difference between the average alpha values of large stocks and small stocks)
- H1a; $\alpha1 \neq \alpha2$, $\beta1 \neq \beta2$ (There exists a significant difference between the average alpha values of large stocks and small stocks)
- H0b: $\alpha1 = \alpha2$, $\beta1 = \beta2$ (There exists no significant difference between the average alpha values of growth stocks and value stocks)
- H1b: $\alpha1 \neq \alpha2$, $\beta1 \neq \beta2$ (There exists a significant difference between the average alpha values of growth stocks and value stocks)
- H0c: $\alpha1 = \alpha2$, $\beta1 = \beta2$ (There exists no significant difference between the average alpha values of up moving stocks and of down moving stocks)
- H1c: $\alpha1 \neq \alpha2$, $\beta1 \neq \beta2$ (There exists a significant difference between the average alpha values of up moving stocks and of down moving stocks)

This hypothesis also adopts the 95% confidence interval as the rejection threshold. Both the P-values and confidence intervals of intercept α and slope β are used for determining whether the null hypothesis should be rejected or not.

4. Findings

4.1. Regression Analysis for Positive Linear Relationship between Stocks' Beta and the Stocks' Actual Return Rate

This section will present a comprehensive finding of the test for relationship between asset real return rate and their matching Beta values in three time frequencies for the whole period from 2012-2020

As previously indicated, the simple returns method will be used to compute the rates of return while the Beta values are calculated from the Beta equation, using FTSE100 index as the market rate. Then the actual return rates on a daily, weekly and monthly basis for all sampled stocks will be averaged, whose results are shown in Table 1 below.

Sticker	DAILY		WEEKLY		MONTHLY	
	Beta	**Avg.Return**	**Beta**	**Avg.Return**	**Beta**	**Avg.Return**
PRU.L	1.498744	0.05671%	1.577038	0.28723%	1.378826	1.12081%
SDR.L	1.250992	0.05423%	1.220127	0.26801%	1.383367	1.14114%
HSBA.L	1.045676	-0.00098%	0.934166	-0.00398%	1.071936	-0.04970%
RR.L	1.35229	0.00688%	1.501424	0.09199%	1.365711	0.24728%
STJ.L	1.213988	0.06846%	1.229878	0.34339%	1.273876	1.41861%
REL.L	0.818166	0.06033%	0.869689	0.30118%	0.870469	1.29476%
MNDI.L	1.177421	0.07131%	1.174484	0.35383%	1.337292	1.52853%
PSN.L	1.141946	0.10725%	1.162679	0.53906%	1.296677	2.32356%
LSEG.L	0.946975	0.12013%	0.823147	0.59179%	0.674717	2.54229%
DCC.L	0.854395	0.06342%	0.880096	0.32609%	0.972999	1.36383%
BT-A-L	0.92398	-0.00041%	0.841359	0.00319%	0.985752	-0.08585%
SLA.L	1.369362	0.03053%	1.378552	0.16135%	1.273353	0.54284%
BA.L	0.856128	0.03316%	0.894465	0.17093%	0.98047	0.70369%
BDEV.L	1.19596	0.11115%	1.235028	0.55371%	1.411323	2.40821%
IAG.L	1.375978	0.05570%	1.526862	0.30211%	1.85385	1.32337%
RMV.L	0.815853	0.08407%	0.855854	0.41786%	1.008759	1.80842%
HL.L	1.177646	0.07496%	0.943183	0.36359%	1.138327	1.62441%
PSON.L	0.805512	-0.00712%	0.829593	-0.03654%	0.684764	-0.22989%
SMDS.L	1.097411	0.06263%	1.147712	0.31553%	1.241476	1.33945%
SK3.IR	1.11995	0.11471%	0.977976	0.56032%	1.299534	2.44467%
ENT.L	0.693673	0.11969%	0.95977	0.62625%	0.904485	2.63862%
TSCO.L	0.723543	-0.01012%	0.847228	-0.04757%	0.718654	-0.26349%
ICP.L	0.723543	-0.01012%	1.552519	0.55727%	1.752747	2.40547%

SMIN.L	1.393166	0.11062%	1.25367	0.17296%	0.981228	0.64169%
ULVR.L	0.679181	0.03753%	0.650122	0.18274%	0.680174	0.79175%
EVR.L	1.619987	0.06260%	1.61925	0.31719%	1.523763	1.46972%
CRH.L	1.29285	0.05382%	1.274267	0.26581%	1.019518	0.98496%
JD.L	0.876214	0.16800%	1.0883	0.84457%	1.249123	3.70739%
LLOY.L	1.222893	0.03416%	1.09932	0.18201%	1.492897	0.78072%
FLTR.L	0.652945	0.07752%	0.660836	0.39762%	0.276322	1.67076%

Table 1: Summary of Mean rate of return and Beta values

Overall, all the Beta values calculated are positive, with some fluctuation among different time frequencies. For instance, the FLTR's Beta changed from 0.653 on the daily basis to 0.276 monthly. Moreover, within the investigated 30 stocks here, the daily basis generates the greatest number of Betas that are higher than one, with totally 21 stocks out of 30..this criteria. Also, the Betas values of stocks declined with the decrease in the examined time frequencies. This difference might indicate that the changes in stocks prices closely follow the market return in the UK financial market.

With the availability of the dependent variables, (the average actual rate of return on sampled stocks) and the independent variables, (the systemic risk of the security, measured by Beta), this paper will proceed to the computation of β1, using the formula shown in Section 3. Only when the slope value of β1 is statistically significant that Formula (1) is regarded as meaningful in identifying the securities' real rate of return. The regression analysis test results on slope β1 coefficient and its investigation are demonstrated in Table 2 below. The complete results of all regression analysis on daily, weekly, and monthly frequencies are shown in Appendix A.

	Daily	Weekly	Monthly
Slope β1 coefficient	0.000132222	0.000731917	0.005850665
t Stat	0.422409944	0.504372103	1.135313698
P-value	0.675951989	0.617946134	0.265869155
Lower 95%	-0.000508968	-0.002240619	-0.004705487
Upper 95%	0.000773412	0.003704454	0.016406816
R squared	0.006332154	0.009003599	0.044007646

Table 2: Results of regression test on the value of slope β1 with the confidence interval (alpha) = 0.05 and degree of freedom equals 29 over the examined period of 2012 to 2020.

Firstly, concerning the actual rate of return on stock on the daily basis, the estimated β1 coefficient is approximately 0.00013544 with a t-stat equal 0.422409943699215 <1.96 and p-value of up to 67.59% , which are exceedingly higher than the rejection threshold of 5%. Additionally, the R-squared that statistically measures the percentage of variance in the daily return on stocks explainable by the variation in Beta values, is only 0.6%., Interpreting from the all the test's statistics, including p-value, the chosen confidence interval, t-stat and R-squared, a conclusion can be drawn that within the 95% confidence interval, the sampled data fail to reject the null hypothesis H0a, $\beta 1a \leq 0$. This indication suggests a invalidity of both CAPM's main theoretical assumptions because there might potentially exist no relationship between the Beta values of stock and their actual rate of return.

The implication against CAPM is further confirmed by the test result on weekly frequency in the United Kingdom financial market. The slope β1 coefficient is positive, however, the p-value for this regression test is comparatively large of up to roughly 61.79% with the 95% confidence interval containing both zero and negative values. Moreover, the t-stat is only 0.504, much lower than the rejection threshold of 1.96. All the statistics have again led to the conclusion that the null hypothesis $\beta 1b \leq 0$ cannot be rejected, hence, cast an extensive questioning on the validity of the Capital Asset Pricing Model.

Similarly, the monthly figure also demonstrates the same implication, with a test's p-value of 26.58% and zero and negative values are within the chosen confidence interval. The R-squared is also much lower than 1. Therefore, the hypothesis, $\beta 1c \leq 0$ cannot be rejected, which implies that the empirical evidence does not support the CAPM's core assumption of a positive and linear relationship between Beta and stock return for the monthly basis.

All in all, there is consistency across the regression test's result of three different time intervals, which suggest that CAPM patterns do not exist in the United Kingdom capital market under the investigating period. Since the relationship between the systematic risk measured by Beta and the rate of return is neither linear nor significant, this paper comes to the conclusion that CAPM is not applicable for pricing securities in the UK.

4.2. Regression Analysis for Comparison of UK stock performance before and after the Brexit Referendum

This section aims at providing a comprehensive interpretation of the regression tests' results of different risk factors in the UK financial market.

	Size				Value				Momentum			
	Big		Small		High P/E		Low P/E		Up		Down	
	Intercept	Slope	Intercept	Slope	Intercept	Slope	Intercept	Slope	Intercept	Slope	Intercept	Slope
Coefficients	4.42E-05	0.891167	-2.78957E-05	0.612831	0.000450142	1.011273196	-0.00036	1.430184357	0.002357	0.519379	-0.00122	1.370803
t Stat	0.177727	18.90225	-0.110654385	12.81963	2.151250699	43.48307529	-0.9778	34.76085682	3.101991	8.367838	-1.74187	23.86324
P value	0.858968	9.94E-70	0.911909446	2.71E-35	0.031661178	2.37E-246	0.328374	2.6122E-182	0.002135	3.69E-15	0.082718	2.41E-67
Lower 95%	-0.000444	0.798667	-0.000522512	0.51904	3.96003E-05	0.965643561	-0.00109	1.349460798	0.000861	0.397156	-0.00261	1.257686
Upper 95%	0.000532	0.983668	0.00046672	0.706623	0.000860683	1.056902831	0.000364	1.510907916	0.003853	0.641602	0.00016	1.48392
R-squared	0.234400192		0.123441515		0.618350298		0.508697189		0.212815518		0.687369599	

	Size				Value				Momentum			
	Big		Small		High P/E		Low P/E		Up		Down	
	Intercept	Slope	Intercept	Slope	Intercept	Slope	Intercept	Slope	Intercept	Slope	Intercept	Slope
Coefficients	-0.000233	-20.7703	3.37762E-06	0.373344	0.000596188	0.953024472	0.000251	1.212788098	0.000524	0.746786	-0.00043	1.478369
t Stat	-0.318196	-0.80798	0.00423408	0.013309	2.402421478	40.74949879	0.78657	40.37192159	0.536184	5.597653	-0.5112	12.81344
P value	0.750393	0.419267	0.99662242	0.989384	0.01644092	3.2787E-227	0.431692	1.9617E-224	0.59229	5.51E-08	0.609647	1.83E-29
Lower 95%	-0.001667	-71.2062	-0.00156174	-54.6658	0.000109301	0.907138882	-0.00037	1.153849467	-0.0014	0.484084	-0.0021	1.251178
Upper 95%	0.001202	29.66551	0.001568495	55.41244	0.001083076	0.998910062	0.000876	1.271726729	0.00245	1.009489	0.001233	1.70556
R-squared	0.000553875		1.50356E-07		0.584995239		0.580468203		0.107552667		0.387058655	

Table demonstrates the results of intercept alpha and slope Beta with significance level alpha = 0.05 over the period from 2012 to June 2016.

Firstly, it is evident that before the Brexit vote's result was announced on 24/06/2016, the slopes β of portfolios constructed from both large and small cap stocks are positive. The p-values of the two portfolios are significantly smaller than 0.05, the confidence interval does not contain 0 and negative value, which can be considered rather significant. This implies a statistically significant relationship between portfolio excess return and the market return for both stocks from large companies and small companies. With regard to the Beta coefficient of two portfolio before the Brexit vote, it can be inferred from the regression tests that the slope value of small-cap stock is lower than that of large-cap stock (0.6128 to 0.891), indicating that small-cap stock experiences less variability compares to large-cap stocks. This finding aligns with the assumption proposed by the Fama & French three-factor model, which asserted that stocks from small companies generally displayed stronger performance than stocks from big companies. Also, the calculated the t-stat based on the two regression tests is 4.19, which is greater than the rejection threshold of 1.96, the null hypothesis $\beta 1a = \beta 2a$ can be rejected and a conclusion is drawn that the above identification of a difference between the Beta of large-cap stock portfolio and that of small-cap stock portfolios is statistically significant. Hence, it is reasonable to claim that during this period, size of the companies is critical to the performance of stocks publicly listed in the LSE.

Nonetheless, in the period after the BREXIT announcement, a considerable transformation can be observed. Both the intercept α and slope $\beta 2$ for the portfolios of big firms' stocks are negative, with the extreme Beta value of -20.77. Also, the t-test p-value is relatively high, up to 41.9% while the confidence interval contains many negative values. They all together lead to the conclusion that in this time frame, the association between portfolios excess return and market excess return is not significant. As for the small stock, even though its regression test yields positive results for both intercept and slope, other testing statistics including a high p-value of 98.9% and the confidence interval all reaffirmed that it is not reasonable to draw a relationship between portfolio return and market return. Since the existence of a relationship between market return and portfolio return is not established, any comparison based on this result is not statistically reliable. However, this paper comes to a disclosure that BREXIT did have a powerful impact on the performance of securities in the UK financial market, but the extent of such impact is yet to be decided and would require much further studies.

Concerning the value factor, it is observable that before the Brexit vote, the slope β of both portfolios are positive, with a relatively small p-value and both confidence intervals do not contain zero or negative value, which assure the existence of a positive and linear relationship between excess return of portfolios and market. With regard to the Beta coefficient of two portfolios, regression test for value portfolios yields a higher value, which suggest that value stocks fluctuated more during the testing period compares to the growth portfolio. This finding is inconsistent with the conclusion by Fama & French, which suggests that value portfolio normally performance better (Fama & French, 1996). The reason for such inconsistency can either be the limitation of this study or the distinct nature of the examined market and period, a more definite answer would require further researches. The calculation of t-stat for the correlation between two slopes yield a result of -8.86. Since the absolute value of t-stat is greater than 1.96, it can be concluded that there is a significant difference between the Beta of value-stock portfolio and growth-stock portfolio. Altogether, the PE ratio is also an important risk factor in the UK financial market, thus, should not be ignored. The data for the period after the Brexit referendum announcement also yields the similar result, which confirmed the importance of the value factor in the UK market.

Lastly, two portfolios for testing the momentum factor both return a positive Beta coefficient with absolute value of t-stat exceeding 1.96 and relatively small p-value, confirming a positive and linear relationship between market risk premium and portfolio return. The comparison between Slope coefficient of portfolio consisting up-moving stocks and down-moving stocks exhibit a considerable disparity, with the value of down-moving is approximately 2 time greater than that of up-moving in both period before and after BREXIT referendum. The test for the difference between two regression coefficients of up and down- moving stocks earn the t-stat absolute values of 10.068 for the before-Brexit period and 4.1477 for the after-Brexit period. As both numbers are larger than the rejection threshold of 1.96, the null hypothesis H0c can be rejected, which lead to a conclusion of a significant difference between up-moving and down-moving portfolio. This result supports the assertion by Carhart that stocks with strong performance tends to continue performing strongly and vice versa (momentum) (Carhart, 1997). All in all, the momentum is a decisive factor in the UK stock markets, both before and after the BREXIT vote, hence investors should take it into consideration when developing investment strategies.

5.Discussion

This paper has provided an examination and empirical test on the hypotheses presented in section 1.3. The first main research question regarding the existence of a linear and positive relationship between Beta values and rate of return on stock, as CAPM suggests have been investigated on three time frequencies and all yield a “No” answer.

This conclusion provides the claim against CAPM validity with another evidence, along with other study’s findings by Khan et al. (2012), Ward & Muller (2015), Hanif (2010), and Džaja and Aljinović (2013). This study has expressed a reasonable doubt over the applicability of CAPM, particularly in the UK stock market based on the empirical result which prove that no positive and linear relationship between the market risk and assets’ rate of return can be identified.

Furthermore, the findings in this research support the assertion by Fama & French (1996) that Beta only is not sufficient in explaining the systematic risk. As the answer for the third hypothesis suggests, other variables including size factor (Fama and French, 1996), value factor (Fama & French, 1996), momentum factor (Carhart, 1997), and possibly some macroeconomic impacts (Nguyen, Vo, & Vo, 2019) are also significant in determining the market risk. These supplementary variables are briefly discussed in this paper and further research should be done in exploring their likely effect in asset pricing. This finding, in contrast, does not agree with conclusions drawn from other researches by Black et al (1972), Levy (2010), Lau et al. (2013) which has successfully discovered a positive and linear relationship between market risk and securities’ actual return or proved that the market risk factor measured Beta suffices in determining the security’s return rate.

Different methodologies adoption for testing can be one main reason behind such divergences. In the research by Black et al. (1972), they have created ten portfolios and run regression tests for the average portfolio return against its Beta values, instead of individual stocks’ mean return and Betas employed in this study. In contrast, some researches that yield results agreeing with this thesis’s findings, for example the work by Džaja and Aljinović (2013), applied a methodology relatively the same to this one. In one of his studies, Roll (1997) even questioned the accuracy of CAPM’s empirical evidence by raising doubt about the unstandardized selection of market proxies in different researches. Furthermore, since this thesis chooses the OLS approach and based the test of data on its assumptions,

Concerning other works of Assets Pricing Model on the UK market, this paper justified the proposal by Bhatnagar & Ramlogan (2012) that CAPM is not sufficient and offers less adequate explanation for the portfolio return than other multi-factor models that take into account the size effect, P/E ratios or momentum variable.

All in all, despite this study's solid support of the assertion that CAPM is not generally applicable due to its theoreticality, the discussion presented here still try to contribute to the ongoing controversy surrounding the applicability of CAPM by disclosing the potential reasons which might have led to the wide inconsistencies of conclusions across studies in this topic.

6. Conclusion

6.1. Main Findings

This thesis has employed the Capital Asset Pricing Model in investigating the UK capital market through three major research questions during the period of 2012-2020.

In answering the first two research questions, the simple returns method was adopted to compute the average stock return on a daily, weekly and monthly basis while the FTSE 100 index is used as the market rate for calculating the stock's Beta values. Then the regression tests are conducted to explore the relationship between stock returns and their corresponding Beta. For the chosen interval of alpha = 0.05, the p-values all fail to reject the hypothesis $\beta 1 \leq 0$, suggesting that within the 95% confidence interval, there is no positive and linear relationship that can be found between Betas values and the securities' actual rate of return.

Regarding the last research hypothesis, this thesis separates the investigating time frame into two periods, the early one is before the Brexit vote result (2012 to 24/06/2016) and the later is after the result was announced (from 25/06/2016 to 31/12/2020). The excess returns of constructed portfolios are regressed against the market risk premium, denoted by the actual return on FTSE 100 Index minus the risk-free rate in two time spans, respectively. After comparing the intercept α and slope β, the conclusion can be drawn that at the significant level of $\alpha = 0.05$, all three factors including size, value and momentum are significant for the UK financial market in the period before the BREXIT vote. However, after BREXIT's result was announced, only the value and momentum factors are discovered to be meaningful to the performance of stocks listed in the London Stock Exchange.

6.2. Limitations

The very first problem that can be realized with this research is the relatively small sample size of 30 stocks, in comparison with the whole populations of 101 stocks constructing the FTSE100 index. Additionally, in testing other risk factors, the selection of only 3 stocks to represent each factor might not entirely reflect the impact of those factors on the United Kingdom capital market. Taking in consideration the scope of this thesis, which is merely concerned with one potential explanatory variable of UK stock returns- the systematic risk β as well as briefly examining other possibly impactful factors, the sample size is appropriate. However, given more recourse, it would be preferable to study a larger sample.

Secondly, the simple return method adopted in this paper is undoubtedly another limitation. Despite the justification for this choice of return calculation method presented in part 3, it is undeniable that log returns are often preferred among researchers as it offers certain advantages in discovering data patterns as well as examining the cause and effect of CAPM applicability.

Additionally, this paper applies the Ordinary Least Square approach in analyzing the regression results, which requires some particular data patterns and might be subject to inaccuracy because of the small sample size. For more concrete conclusion, other precise methods and tests for the presumption of those methods should be considered.

Furthermore, the findings of Brexit potential impact on the UK stock market may suffer from bias as the investing period also takes into account the data during the COVID-19 pandemic from 2019 to 2020, which is a highly fluctuated time.

The aforementioned shortcomings lead to the overall drawback that neither the examination nor the analysis of the dominant cause behind the rejection of CAPM applicability here. The answer to whether CAPM is rejected due to the market, the UK stocks samples or due to its own deficiencies is still open to question.

6.3. Suggestion for future Research

Regarding the above limitations of this paper, future research on the same topic should seriously consider them to obtain more reliable results. An adequately larger sample for testing the model with higher confidence, analysis of results from different methodologies, particularly with concerns to the computation of stock portfolio returns and regression approaches, and, lastly, sensitivity analysis for determining the variables dominating the results would help enhance the quality of later paper conducted in this field.

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APPENDICES

APPENDIX A

Regression test result of Equation (1) on the daily basis:

SUMMARY OUTPUT

Regression Statistics	
Multiple R	0.079574833
R Square	0.006332154
Adjusted R Square	-0.029155983
Standard Error	0.000453569
Observations	30

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	3.67075E-08	3.67E-08	0.17843	0.675951989
Residual	28	5.7603E-06	2.06E-07		
Total	29	5.79701E-06			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*
Intercept	0.00046294	0.000343156	1.349066	0.188125	-0.000239983	0.001166
Beta	0.000132222	0.000313019	0.42241	0.675952	0.000508968	0.000773

Regression test result of Equation (1) on the weekly basis:

SUMMARY OUTPUT

Regression Statistics	
Multiple R	0.094887298
R Square	0.009003599
Adjusted R Square	-0.026389129
Standard Error	0.00215436
Observations	30

ANOVA

	df	SS	MS	F	Significance F
Regression	1	1.1807E-06	1.18E-06	0.254391218	0.617946134
Residual	28	0.000129955	4.64E-06		
Total	29	0.000131136			

	Coefficients	Standard Error	t Stat	P-value	Lower 95%	Upper 95%
Intercept	0.002331175	0.001644409	1.417637	0.167329844	-0.0010372	0.005699595
Beta	0.000731917	0.001451145	0.504372	0.617946134	-0.002240619	0.003704454

Regression test result of Equation (1) on the monthly basis:

SUMMARY OUTPUT

Regression Statistics	
Multiple R	0.20978
R Square	0.044008
Adjusted R Square	0.009865
Standard Error	0.00946
Observations	30

ANOVA

	df	SS	MS	F	Significance F
Regression	1	0.000115	0.000115	1.288937	0.265869155
Residual	28	0.002506	8.95E-05		
Total	29	0.002621			

	Coefficients	Standard Error	t Stat	P-value	Lower 95%	Upper 95%
Intercept	0.006562	0.006107	1.07443	0.291799	-0.005948374	0.019072283
Beta	0.005851	0.005153	1.13531	0.265869	-0.004705487	0.016406816

APPENDIX B

Regression test result for large-cap portfolio before BREXIT:

SUMMARY OUTPUT

Regression Statistics	
Multiple R	0.484148936
R Square	0.234400192
Adjusted R Square	0.233744151
Standard Error	0.008496898
Observations	1169

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	0.025795732	0.025796	357.29505	9.93544E-70
Residual	1167	0.084254228	7.22E-05		
Total	1168	0.11004996			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*
Intercept	4.41878E-05	0.000248628	0.177727	0.8589685	-0.00044362	0.000531995
XSMarket return	0.891167098	0.047146086	18.90225	9.935E-70	0.798666532	0.983667664

Regression test result for large-cap portfolio after BREXIT:

SUMMARY OUTPUT

Regression Statistics	
Multiple R	0.023534553
R Square	0.000553875
Adjusted R Square	-0.000294551
Standard Error	0.010669148
Observations	1180

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	7.43117E-05	7.43E-05	0.652827	0.419267056
Residual	1178	0.134092586	0.000114		
Total	1179	0.134166898			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*

Intercept	-0.000232603	0.000731005	-0.3182	0.750393	-0.00166682	0.001201615
XSMarket return	-20.77034883	25.70661494	-0.80798	0.419267	-71.2062089	29.66551124

Regression test result for small-cap stock before BREXIT:

SUMMARY OUTPUT

Regression Statistics	
Multiple R	0.351342447
R Square	0.123441515
Adjusted R Square	0.122690394
Standard Error	0.008615491
Observations	1169

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	0.012198635	0.012199	164.343	2.70792E-35
Residual	1167	0.086622536	7.42E-05		
Total	1168	0.098821171			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*
Intercept	-2.78957E-05	0.000252098	-0.11065	0.911909	-0.000522512	0.000467
XS market return	0.612831155	0.04780411	12.81963	2.71E-35	0.519039546	0.706623

Regression test result for small-cap stock after BREXIT:

SUMMARY OUTPUT

Regression Statistics	
Multiple R	0.000387758
R Square	1.50356E-07
Adjusted R Square	-0.000848746
Standard Error	0.011642912
Observations	1180

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*

Regression	1	2.40098E-08	2.4E-08	0.000177	0.989383827
Residual	1178	0.159686614	0.000136		
Total	1179	0.159686638			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*
Intercept	3.37762E-06	0.000797723	0.004234	0.99662	-0.00156174	0.001568
XS Market return	0.373344441	28.05283548	0.013309	0.989384	-54.66575302	55.41244

Regression test result for high P/E ratio portfolio before BREXIT:

SUMMARY OUTPUT

Regression Statistics	
Multiple R	0.786352528
R Square	0.618350298
Adjusted R Square	0.618023263
Standard Error	0.007151735
Observations	1169

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	0.096708209	0.096708	1890.778	2.3657E-246
Residual	1167	0.059688916	5.11E-05		
Total	1168	0.156397126			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*
Intercept	0.000450142	0.000209246	2.151251	0.031661	3.96003E-05	0.000861
XS Market return	1.011273196	0.023256708	43.4830	2.4E-246	0.965643561	1.056903

Regression test result for high P/E ratio portfolio after BREXIT:

SUMMARY OUTPUT

Regression Statistics	
Multiple R	0.764849815
R Square	0.584995239
Adjusted R Square	0.584642943
Standard Error	0.008523164
Observations	1180

ANOVA

	df	SS	MS	F	Significance F
Regression	1	0.120627478	0.120627478	1660.521652	3.2787E-227
Residual	1178	0.085575018	7.26443E-05		
Total	1179	0.206202496			

	Coefficients	Standard Error	t Stat	P-value	Lower 95%	Upper 95%
Intercept	0.000596188	0.000248161	2.402421478	0.01644092	0.000109301	0.001083
Market risk premium	0.953024472	0.023387391	40.74949879	3.2787E-227	0.907138882	0.99891

Regression test result for low P/E ratio portfolio before BREXIT:

SUMMARY OUTPUT

Regression Statistics	
Multiple R	0.71323011
R Square	0.508697189
Adjusted R Square	0.508276193
Standard Error	0.012652161
Observations	1169

ANOVA

	df	SS	MS	F	Significance F
Regression	1	0.193424016	0.193424016	1208.317167	2.6122E-182
Residual	1167	0.18681008	0.000160077		
Total	1168	0.380234097			

	Coefficients	Standard Error	t Stat	P-value	Lower 95%	Upper 95%
Intercept	-0.000361962	0.000370179	-0.977803298	0.328374269	-0.001088252	0.000364328
XS Marker return	1.430184357	0.04114353	34.76085682	2.6122E-182	1.349460798	1.510907916

Regression test result for low P/E ratio after BREXIT:

SUMMARY OUTPUT

Regression Statistics	
Multiple R	0.761884639

R Square	0.580468203
Adjusted R Square	0.580112064
Standard Error	0.010947743
Observations	1180

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	0.195347562	0.195347562	1629.892053	1.9617E-224
Residual	1178	0.141186914	0.000119853		
Total	1179	0.336534476			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*
Intercept	0.000250724	0.000318756	0.786569734	0.431691984	-0.000374669	0.000876116
Market premium	1.212788098	0.030040386	40.37192159	1.9617E-224	1.153849467	1.271726729

Regression test result for up-moving portfolio before BREXIT:

SUMMARY OUTPUT

Regression Statistics	
Multiple R	0.461319323
R Square	0.212815518
Adjusted R Square	0.209776196
Standard Error	0.012273055
Observations	261

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	0.010547072	0.010547072	70.02071354	3.68831E-15
Residual	259	0.039012622	0.000150628		
Total	260	0.049559694			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*
Intercept	0.00235663	0.000759716	3.101990508	0.002134943	0.000860625	0.003852636
XS Market return	0.519378792	0.062068457	8.367838044	3.68831E-15	0.397155725	0.641601859

Regression test for up-moving portfolio after BREXIT:

SUMMARY OUTPUT

Regression Statistics	
Multiple R	0.327952232
R Square	0.107552667
Adjusted R Square	0.104120177
Standard Error	0.015743649
Observations	262

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	0.007766453	0.007766	31.33372	5.50998E-08
Residual	260	0.064444242	0.000248		
Total	261	0.072210695			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*
Intercept	0.000524361	0.000977949	0.536184	0.59229	-0.00140134	0.002450069
XS Market return	0.746786408	0.133410631	5.597653	5.51E-08	0.484083532	1.009489284

Regression test result for down-moving portfolio before BREXIT:

SUMMARY OUTPUT

Regression Statistics	
Multiple R	0.829077559
R Square	0.687369599
Adjusted R Square	0.686162531
Standard Error	0.011358666
Observations	261

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	0.073470595	0.073471	569.4543	2.41026E-67
Residual	259	0.033415999	0.000129		
Total	260	0.106886594			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*

Intercept	-0.001224733	0.000703114	-1.74187	0.082718	-0.002609281	0.000159815
XS Marker return	1.370802967	0.057444122	23.86324	2.41E-67	1.25768598	1.483919954

Regression test result for down-moving portfolio after BREXIT:

SUMMARY OUTPUT

Regression Statistics	
Multiple R	0.622140382
R Square	0.387058655
Adjusted R Square	0.384701188
Standard Error	0.013615455
Observations	262

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	0.03043656	0.030437	164.1841	1.82818E-29
Residual	260	0.048198963	0.00018		
Total	261	0.078635523			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*
Intercept	-0.00043234€	0.000845752	-0.5112	0.609647	-0.002097742	0.001233
XS Market return	1.478368945	0.115376464	12.81344	1.83E-29	1.251177688	1.70556